植 物 分 类 学 报 33(5):461～468(1995)
Acta Phytotaxonomica Sinica

广西九万山藓类植物区系分析及其对划分热带、亚热带分界线的意义*

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THE MOSSFLORA OF MT. JIUWAN, GUANGXI AND ITS SIGNIFICANCE IN DIVIDING THE BOUNDARY LINE BETWEEN TROPICAL AND SUBTROPICAL REGIONS IN CHINA

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Abstract The Jiuwan Mountains, situated in the middle of northern Guangxi, South China (25°10'～25°25'N, 108°27'E), is a transitional region between the Holarctic flora and Paleotropical flora. Its main vegetation is subtropical evergreen broad-leaved forests consisting of the Lauraceae, Teaceae, Fagaceae and Magnoliaceae. The highest peak of the mountains is 1693 m above sea level, and its bottom is only 170 m.

In 1931, H. Reimers first reported the mossflora of Guangxi titled "Beitraege Zur Mossflora China I". Four years later, Edwin B. Bartram published "Additions to the mossflora of China". Hu Sun-si (1981) reported twenty-five species of mosses in Guangxi in "Preliminary observation on bryophytes in the evergreen broad-leaved forest of Huaping Forest Region in Guangxi". Up to then reported were about 25 families, 43 genera and 62 species of mosses in Guangxi.

In 1989, Li Zhen-yu, Long Guang-ri and Zhang Can-ming made the first botanical expedition to the mountains and about 500 packages of bryophytes were collected there. One year later, Wang Mei-zhi, He Xiao-lan and the first author of this paper made bryophytic survey in the mountains, and about 1350 packages of bryophtes were collected there. From all the above specimens, 35 families, 101 genera and 189 species of Mosses are identified. According to "The areal-types of Chinese genera of seed plants" by Wu Zheng-yi, ten type

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* 国家自然科学基金资助项目。
1993-12-02 收稿。

of the mossflora of the Jiuwan Mountains are recognized: Cosmopolitans (8 families and 9 genera), Pantropical elements(7 families and 8 genera), Paleotropical elements (4 families and 4 genera), Tropical Asian to African elements (4 families and 5 genera), Tropical Asian elements (19 families and 33 genera), North Temperate elements (9 families and 17 genera), East Asian & North American disjunctive elements (6 families and 6 genera), Temperate Asian elements (4 families and 4 genera), East Asian elements (71 species), Endemic to China (5 species). Totally, the East Asian elements are the most important ones (39. 33%), then the tropical and subtropical elements (38. 20%) are also abundant, and the temperate elements (18. 54%) are the third one.

For considering the relationships between the mossflora of the Jiuwan Mountains and those of the neighbouring regions, the authors selected five regions around the Mountains. The similarity coefficient of moss genera between the Jiuwan Mountains and the Jinfu Mountains, east Sichuan, is 60. 68%,and that of moss species is 36. 87% . The similarity coefficient of moss genera and species between the Jiuwan Mountains and the Wuyi Mountains are 69. 86% and 39. 57% respectively, higher than those of the other mountain regions. Comparing the mossfloras of the Jiuwan Mountains and the Jianfeng Mountains, there are fourty species commonly, among them thirty-two species are tropical elements which clearly show the close affinity to the tropical mossflora. The similarity coefficient of moss genera and species of the above two mountain are 57. 29% and 29. 63% rsepectively. Due to the influence of the Himalayas, the tropical elements of Xishuangbanna are different from the Jiuwan Mountains and the Jianfeng Mountains. Floristically, Shennongjia is situated in the transitional region between West and East China, and the similarity coefficient of moss genera and species between the Jiuwan Mountains and Shennongjia are 57. 29% and 33. 13%.

East-Asiatic endemic genera of the bryophytes are regarded as "Tertiary fossil plants" which enjoy a warm and moist environment. They are mainly limited to temperate and subtropical region. Though there are some species of East-Asiatic element in Xishuangbanna, East-Asiatic endemic genera so far have not been found. There are two genera of East-Asiatic endemic genera of the bryophytes in Jianfengling belonging to tropical region. Nine of East-Asiatic endemic genera of the bryophytes have been recorded in Mt. Jinfu, and show the characteristic of overlapping distribution between Eastern and Western.

Topographically, the Jiuwan Mountains is located at the Southeast of the Yunnan-Guizhou plateau, the edge of second step of China, so far four East Asiatic endemic genera, *Taiwanobryum*, *Pilotriopsis*, *Meteoriella* and *Neobarbella* have been found. Among them the former two genera are distributed in Japan and the Philippines, however, *Meteoriella* is found in Nepal and Japan, as well, it was widely recorded in South of Yangtze River and at 2000 meters above the sea level of the evergreen forest in Southeastern Xizang(Tibet), China. *Neobarbella* occurs in Sikkim, India, the Philippines, Indonesia and Japan, and China is

recognized as the distribution centre of this genus. Generally, the above data show that the East Asiatic endemic genera of mosses are evidently influented by the Himalayas.

In the Jiuwan Mountains, it is worth to notice that there are about 7% of the tropical species of mosses, such as *Syrrhopodon flamme-nervis*, *Hookeriopsis geminidens*, *Pterobryopsis crassicaulis* and *Garovaglia plicata* , which clearly indicate the close relationships of the mossflora of Mt. Jiuwan with the tropical elements. However, some tropical mosses, such as *Pyrrhogonium spiniforme* and *Chrysocladium retrorsum*, which are found at about 1000 meters above the sea level, also distribute to the South of Yangtze River.

The geological data showed that the formation of the South China Sea was the very important event happened in South China in Tertiary. Hainan Island, as one of the migration route with South Asia and South Hemisphere, connected with the Asia continent until the late tertiary. Before that period of time, the Jiuwan Mountains was under the control of the tropical and subtropical climate with Xishuangbanna and Taiwan. Owing to the submergence of Qiongzhou Strait, Hainan Island became an isolated island, then the South Sea gradually formed. A series tropical species occuring in the Jiuwan Mountains might be the evidence of the migration between Laurasia and Gondwana ancient continent.

Several moss genera, *Garovaglia*, *Oedicladium*, *Pterobryopsis*, *Leucoloma*, *Dicranoloma* and *Callicostella*, occuring both in North and South Heimephere, are found in the Jiuwan Mountains now. They might show the bryoflora relationships between the Jiuwan Mountains of South China and Africa, Central and South America. In fact, South America connected with Africa before Jurassic, and the Pacific Ocean and Atlantic Ocean were not so broad as right now.

The ordination method was used for calculating the figure of two dimensional arrangement, the mossflora of the Jiuwan Mountains is very close to that of the Wuyi Mountains. However the typical tropical mosses occuring in the Jiuwan Mountains have not been found in the later mountain region. The Wuyi Mountains, the natural defence for South China, is recognized as the boundary line between Central subtropical and South subtropical region in China. While the mossflora of the Jiuwan Mountains is represented the tropical relationships, but its subtropical elements are still abundant.

Depending on the quantitative and qualitative analysis, the authors consider that the mossflora of the Jiuwan Mountains represents the transitional characteristic from tropical region to subtropical region in South China, and in Guangxi the boundary line between them might be set at the south of the Jiuwan Mountains.

Key words　The Jiuwan Mountains; Northern Guangxi; Mossflora; Boundary line between the tropical and subtropical regions; South China

摘要　九万山位于广西北部的中央(25°10'～25°25'N, 108°27'E)，界于泛北极植物区和古热带植物区的交汇处。其主要植被为亚热带常绿阔叶林。最高海拔为 1693 m，最低处仅 170 m。经对 1850 号标本的鉴定，共计有藓类植物 35 科、101 属和 189 种。本文分析了九万山的藓类植物区系成分，将其划分为

10种类型。其中东亚成分最为丰富(39.33%),热带、亚热带成分次之(38.20%),而温带成分居第三位(18.54%)。本文选择了九万山临近的五个地区加以比较。其中,金佛山与九万山藓类植物的属和种的相似性系数分别为60.68%和36.87%,神农架为57.29%和33.13%。尖峰岭为48.83%和22.29%,西双版纳为57.29%和29.63%。而我国东部的武夷山则为69.86%和39.57%,其相似性系数在相比较的五个山区中为最高。九万山区有4个特有属并明显受喜马拉雅的影响。特别值得注意的是,在九万山区藓类区系中约有7%的种类是典型的热带成分。根据定量和定性的分析,笔者认为九万山的藓类区系表现出由热带向亚热带过渡的特性,其分界线可能位于九万山的南侧。
关键词 广西九万山;藓类区系;热带、亚热带分界线;中国南部

0 引言

1989～1990年中国科学院植物研究所和广西柳州地区林业局联合开展对九万山地区的植物资源考察。据初步统计,该地区的维管植物在3000种以上。迄今,对广西的苔藓植物尚未有系统、全面的研究,而就九万山地区的苔藓植物的采集和研究更是空白。最早报道广西苔藓植物的是Reimers(1931),记录广西藓类植物14科、18属和20种。他还发表了3个新种:*Syrrhopodon sinii* Reim.、*Tayloria kwangsiensis* Reim.(=*Tayloria indica* *Mitt.*)和*Hypnum pseudorevolutum* Reim.(=*Stereodontopsis pseudo-revolutum* (Reim.) Ando)。Bartram (1935)一文,记录藓类植物14科、20属和24种,其中增加了21种并发表1个新种:*Macromitrium sinense* Bartram。此后,胡舜士(1981)再记录藓类植物15科、17属和25种,其中仅4种在上述两文已有记载外,其余均为新记录。另外,汪楣芝(1993)报道了广西九万山地区的苔类植物20科、36属和73种。从上述报道总计广西地区藓类植物有:25科、43属和62种。

1989～1990年10～11月的野外调查(图1),共采集近1850号苔藓植物标本。经鉴定,现知九万山地区已有藓类植物35科、101属和189种。在前人研究的基础上,本文对九万山藓类植物区系进行了分析研究,并探讨了其对划分热带、亚热带分界线的意义。

1 九万山地区的自然概况

九万山位于广西北部,东经108°27′～108°59′,北纬25°10′～25°25′,处于我国热带、亚热带交汇处,包括融水县、罗城县和环江县,南北长40～59 km,东西宽28～48 km,总面积为1204 km^2,两侧与贵州省接壤,北临贝江,南至罗城县腊洞村。

九万山在地质区域构造体系中,属于南淮地台桂北迭隆起的西端凸起部分。经过四堡、雪峰、加里东、印支等漫长的地质构造运动,形成了当今九万山的轮廓。在地貌方面,九万山属于中山类型,其特征是山高、坡陡及切割深削。最高海拔为1693m,本地区海拔1500 m以上有老高山(1683 m)等14个山峰,最低海拔为170 m,最大高差1523 m,一般相对高差600～900 m,坡度在35°以上,河谷切割深而多呈"V"字形。其岩层主要由沙岩、泥岩、千枚岩和花岗岩所组成。土壤形成受中亚热带气候、生物和地形地貌的综合影响,地带性土壤为红壤。垂直分布明显,一般自下而上依次为:山地红壤→山地黄红壤→山地黄壤→山地草甸土。气候的主要特点是冬冷夏凉,日温差变化大。雨量丰富而湿度较大。日照时间短,年日照为1000～1200 h。年均气温12～17.1℃。山区年均最高温度为22.0～

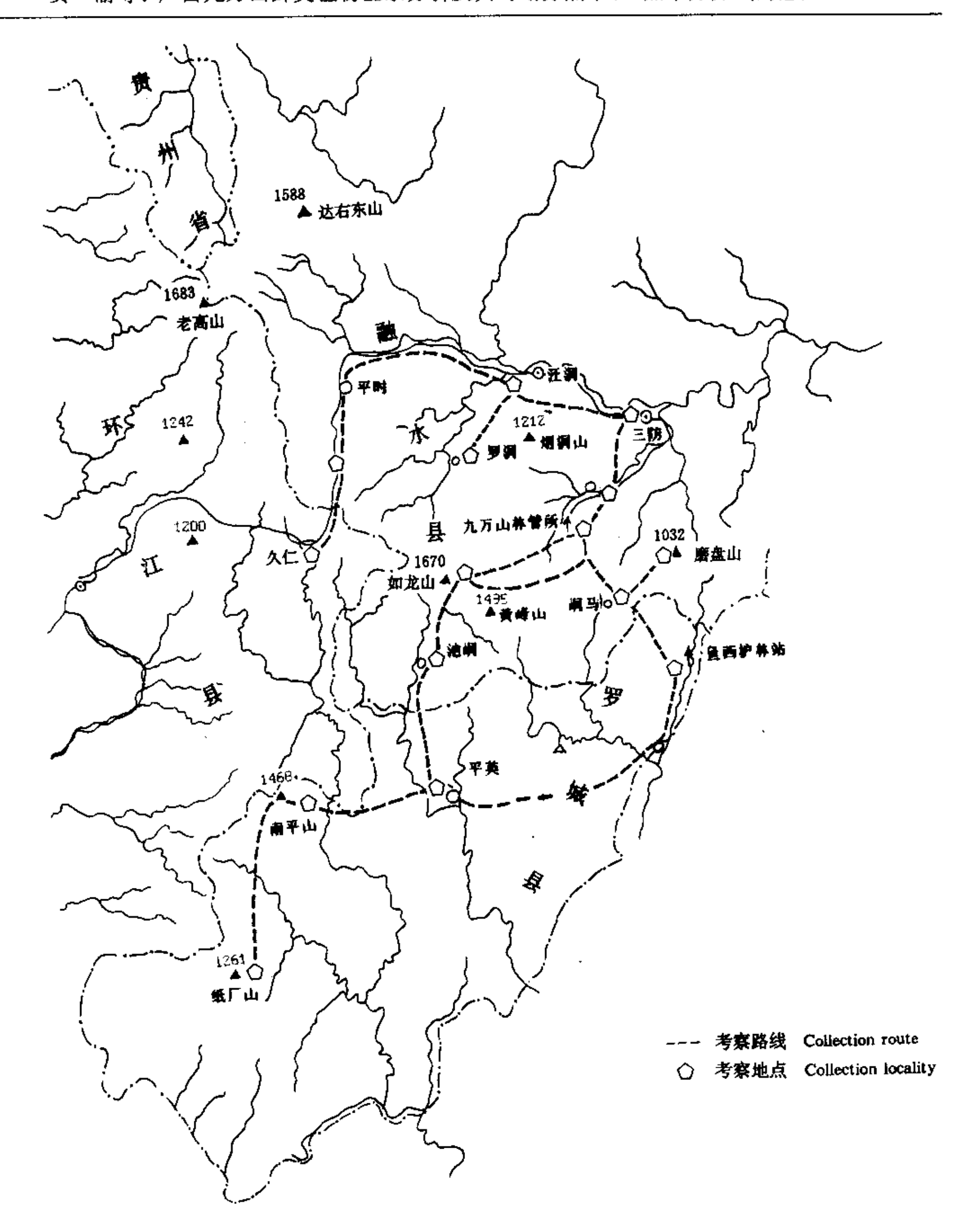


图 1　九万山野外考察路线图

Fig. 1　The auther's collection route in the Jiuwan Mountains, Guangxi, in 1990

25.0℃，年均最低温度为 4.0～6.0℃，年均日温差 7.5～12.2℃。年平均降雨量 1600～2100 mm，多雨年达 2313.7 mm，相对湿度 82.0～90.0%。总的说来是雾多、雨多、湿度大。本地区地处南亚热带气候区，深受季风和环流影响，夏季盛行海洋湿润气团，冬季则为大陆寒冷气团。

本地区的地带性植被为中亚热带常绿阔叶林，以壳斗科 Fagaceae、樟科 Lauraceae、山茶科 Theaceae、木兰科 Magnoliaceae 等的常绿树种为建群成分。在海拔 1000～1100 m

以下为亚热带山地常绿阔叶林，优势种为栲树 *Castanopsis fargesii*、红甜槠 *C. neocavalerei*、光叶柯 *Lithocarpus hancei*、银木柯 *Schima argentea*、红楠 *Machilus thunbergii* 和南方木莲 *Manglietia chingii* 等。在海拔 1000～1300 *m* 的中山地带为亚热带山地常绿、落叶混交林，优势种有：大鳞柯 *Lithocarpus elizabethae*、竹叶稠 *Quercus bumbusifolia*、水青冈 *Fagus longipetiolata*、青榨槭 *Acer davidii*、云贵鹅耳枥 *Carpinus pubescens*、光皮桦 *Betula luminifera* 和苦枥木 *Fraxinus retusa* 等。

在海拔 1300～1500 *m* 以上为亚热带山地落叶阔叶林，优势种为亮叶水青冈 *Fagus lucida*、裂叶白辛树 *Pterostyrax leveillei* 和华南桦 *Betula austrosinensis* 等。组成本地区植被的区系成分来源广泛，但从种子植物属级水平分析，以热带性质较为明显，所有各类热带分布类型占该区全部属数的 61.07%，它们包括的种数占该地区总种数的 56.75%（李振宇等，1993）。

2 九万山藓类植物区系成分

本文依据《中国种子植物属的分布区类型》（吴征镒，1991）划分九万山的藓类植物为下列区系成分。

2.1 世界广布成分 Cosmopolitans 在九万山藓类植物中属于此类成分的有 11 种，属于 8 科 9 属，如：多形小曲尾藓 *Dicranella heteromalla*、长蒴藓 *Trematodon longicollis*、卷叶凤尾藓 *Fissidens cristatus*、鳞叶凤尾藓 *F. taxifolius*、真藓 *Bryum argenteum*、细叶真藓 *B. capillare*、钝叶匍灯藓 *Plagiomnium rostratum*、泽藓 *Philonotis fontana*、虎尾藓 *Hedwigia ciliata*、金发藓 *Polytrichum commune* 和舌叶藓 *Scopelophila cf. ligulata* 等。

2.2 泛热带成分 Pantropical elements 本地区藓类植物中属于此类的有 8 种，属 7 科和 8 属，它们是：南亚曲柄藓 *Campylopus richardii*、卷叶湿地藓 *Hyophila involuta*、刺叶桧藓 *Pyrrhogonium spiniforme*、拟扭叶藓卷叶变种 *Trachypodopsis serrulata* var. *crispatula*、双色扭叶藓 *Trachypus bicolor*、尖叶油藓 *Hookeria acutifolia*、羊角藓 *Herpetineuron toccoae* 和小羽藓 *Bryohaplocladium angustifolium*。

2.3 古热带成分 Paleotropical elements 九万山藓类植物中有 4 种，属 4 科、4 属，这些种类有：大灰气藓 *Aerobryopsis subdivergens*、小树平藓 *Homaliodendron exiguum* 和大羽藓 *Thuidium cymbifolium* 和 *Fissidens zippelianus* 等。

2.4 热带亚洲至大洋洲成分 Tropical Asian and Oceanian elements 在九万山有 6 种（属于 4 科、5 属）属于此分布类型，它们是：小扭叶藓 *Trachypus humilis*、垂藓 *Chrysocladium retrorsum*、蔓藓 *Meteorium miquelianum*、树平藓 *Homaliodendron flabellatum*、明叶藓 *Vesicularia montagnei* 和长尖明叶藓 *V. reticulata*。

2.5 热带亚洲和非洲成分 Tropical Asian and Tropical African elements 此成分在本地区仅 1 种：暖地大叶藓 *Rhodobryum giganteum*。

2.6 热带亚洲及太平洋成分 Tropical Asian elements 九万山地区具本分布类型的藓类植物有 49 种，属于 19 科、33 属。如曲尾藓科 5 种，有：台湾锦叶藓 *Dicranoloma assimile*、格氏苞领藓 *Holomitrium densifolium*、柔叶白锦藓 *Leucoloma molle* 等。白发藓科有包氏白发藓 *Leucobryum bowringii*、南亚白发藓 *L. neilgherrense* 和爪哇白发藓 *L. javense* 等。花

叶藓科有日本网藓 *Syrrhopodon japonicus* 和红肋网藓 *S. flammeo-nervis* 2 种。提灯藓科有 大叶匍灯藓 *Plagiomnium succulentum* 1 种。隐蒴藓科有毛枝藓 *Pilotrichopsis dentata*。毛藓科有台湾藓 *Taiwanobryum speciosum*。蕨藓科有绳藓 *Garovaglia plicata*、拟蕨藓属 *Pterobryopsis*。金毛藓科有红色金毛藓 *Oedicladium rufescens*。平藓科有 1 种：刀叶树平藓 *Homaliodendron scalpellifolium*。船叶藓科有双肋藓 *Elmeriobryum philippinense*。油藓科有 4 种，如：并齿拟油藓 *Hookeriopsis geminidens* 和东亚黄藓 *Distichophyllum maibarae* 等。孔雀藓科有短肋雉尾藓 *Cyathophorella hookeria* 1 种。羽藓科有拟灰羽藓 *Thuidium glaucinoides* 等 3 种。蔓藓科有 6 属和 11 种，有气藓 *Aerobryum speciosum*、鞭枝悬藓 *Barbella flagellifera*、南亚假悬藓 *Pseudobarbella levieri* 和扭叶松萝藓 *Papillaria semitorta* 等。锦藓科有 3 属和 3 种，乳突刺疣藓 *Trichosteleum mammosum* 和短肋竹藓 *Aptychella brevinervis* 等。灰藓科有 平叶偏蒴藓 *Ectropothecium zollingerii* 和纤枝同叶藓 *Isopterygium minutirameum* 2 种。塔藓科有 南木藓 *Macrothamnium macrocarpum* 以及短颈藓科有东亚短颈藓 *Diphyscium fulvifolium*。

2.7　北温带成分 North Temperate elements　在九万山该分布类型有 23 种，属于 9 科、17 属。包括曲尾藓科 4 属和 6 种，常见的有：长叶曲柄藓 *Campylopus atro-virens*、山曲背藓 *Oncophorus wahlenbergii* 和青毛藓 *Dicranodontium denudatum* 等。丛藓科 3 属和 4 种，如 酸土藓 *Oxystegus cylindricus* 和对齿藓 *Didymodon acutus* 等。紫萼藓科仅 1 种：异枝砂藓 *Racomitrium heterostichum*。真藓科有 *Bryum cyclophyllum* 和丝瓜藓 *Pohlia elongata* 等 2 种。青藓科有 2 属和 2 种，常见的如：羽枝青藓 *Brachythecium plumosum*。提灯藓科有 2 属和 3 种，如：提灯藓 *Minum hornum* 和尖叶匍灯藓 *Plagiomnium cuspidatum* 等。绢藓科有密叶绢藓 *Entodon compressus* 和短柄绢藓 *Entodon macropodus* 等 2 种。棉藓科 1 种：圆条棉藓 *Plagiothecium curvifolium*。金发藓科有 1 属和 2 种，如：仙鹤藓 *Atrichum undulatum* 等。

2.8　东亚-北美间断成分 East Asian and North American elements　九万山地区有该分布类型 6 种，属于 6 科、6 属，它们是：拟扁枝藓圆叶变种 *Homaliadelphus sharpii* var. *rotundatus*、东亚孔雀藓 *Hypopterygium japonicum*、暗绿多枝藓 *Haplohymenium triste*、多疣悬藓 *Barbella pendula*、绢藓 *Entodon sullivantii* 和扭叶小金发藓 *Pogonatum contortum* 等。

2.9　温带亚洲成分 Temperate Asian elements　本地区有 4 种：拟合睫藓 *Pseudosymblepharis angustata*、拟拊干藓 *Schwetschkeopsis fabronia*、大灰藓 *Hypnum plumaeforme* 和东亚小金发藓 *Pogonatum inflexum*。

2.10　东亚成分 East Asian elements　它们还可以分布范围分为两个类型：

2.10.1　中国-喜马拉雅成分 Sino-Himalayan elements　此成分在九万山有 8 种属于 4 科、7 属，它们是 *Aerobryopsis membrance*、*Barbella spiculata*、*Chrysocladium flammeum*、粗垂藓 *Ch. phaeum*、扭尖松萝藓 *Papillaria feae*、小蔓藓 *Meteoriella soluta* 和刺边毛柄藓 *Calyptrochaeta spinosus* 等。

2.10.2　中国-日本成分 Sino-Japanese elements　此分布类型在该地区有 61 种，属于 27 科、44 属。曲尾藓科有日本曲柄藓 *Campylopus japonicus* 和东亚曲尾藓 *Dicranum nipponense* 等 2 种。白发藓科仅 1 种：疣白发藓 *Leucobryum scabrum*。凤尾藓科 1 属 4 种，如：拟

小凤尾藓 *Fissidens tosaensis* 和南京凤尾藓 *F. adelphinus* 等。花叶藓科的东亚网藓 *Syrrhopodon tosaensis*。丛藓科的3属和3种,如:*Hyophila spathulata* 和阔叶毛口藓 *Trichostomum platyphyllum* 等。真藓科的短月藓 *Brachymenium nepalense*。提灯藓科的3属和7种,如:平肋提灯藓 *Mnium laevinerve*、侧枝匐灯藓 *Plagiomnium maximoviczii* 和疣灯藓 *Trachycystis microphylla* 等。桧藓科仅大桧藓 *Pyrrhogonium dozyanum* 1种。珠藓科有毛叶泽藓 *Philonotis lancifolia* 和细叶泽藓 *Philonotis socia* 2种。木灵藓科有2属和5种,如:缺齿蓑藓 *Macromitrium gymnostomum*、钝叶蓑藓 *M. japonicum* 和东亚火藓 *Schlotheimia japonica* 等。卷柏藓科的毛尖卷柏藓 *Racopilum aristatum*;鳞叶藓科仅小粗疣藓 *Fauriella tenerrima*1种。蕨藓科1种:急尖耳平藓 *Calyptothecium hookeri*。蔓藓科的3属和4种,如:新悬藓 *Neobarbella attenuata*、波叶粗蔓藓 *Meteoriopsis undulata* 和粗枝蔓藓 *Meteorium subpolytrichum* 等。平藓科的5属和5种,常见的有:疣叶树平藓 *Homaliodendron papillosum*、叶木藓 *Thamnobryum sandei* 和异猫尾藓 *Isothecium subdiversiforme* 等。油藓科仅柔叶毛柄藓 *Calyptrochaeta japonica* 1种。薄罗藓科有拟草藓 *Pseudoleskeopsis zippelii*。羽藓科的短肋羽藓 *Thuidium kanedae*。绢藓科有广叶绢藓 *Entodon flavescens* 和绢藓 *E. viridulus* 2种。金毛藓科的拟金毛藓 *Eumyurium sinicum*。棉藓科有棉藓 *Plagiothecium euryphyllum* 1种。锦藓科的2属和3种,如:南方小锦藓 *Brotherella henonii* 和美锦藓 *Sematophyllum pulchellum* 等。青藓科的3属和5种,如:勃氏青藓 *Brachythecium brotheri*、燕尾藓 *Bryhnia noesia* 和美喙藓 *Eurhynchium savatieri* 等。灰藓科4属和4种,如:毛叶梳藓 *Ctenidium capillifolium*、东亚毛灰藓 *Homomallium connexum* 和南亚灰藓 *Hypnum oldhamii* 等。金发藓科的1属2种:拟刺边小金发藓 *Pogonatum spurio-cirratum* 和 *P. spinulosum*。孔雀藓科仅1种:长肋孔雀藓 *Hypopterygium fauriei*。

2.11 中国特有成分 Elements endemic to China 九万山藓类植物中,中国特有成分有5种:小火藓 *Schlotheimia pungens*、狭叶假悬藓 *Pseudobarbella angustifolia*、延叶平藓 *Neckera decurrens*、台湾多枝藓 *Haplohymenium formosanum* 和 *Trachypodopsis formosana* 等。

(待续 To be continued)